SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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SOME ECONOMIC AND SOCIAL PROBLEMS OF SOIL CONSERVATION

By ARTHUR C. BUNCE [1]

THE PROBLEMS of soil conservation, as seen from an economic and social point of view, may be summarized in four rather broad statements: (1) We need to know when exploitation becomes uneconomic, and the factors that determine the level whereon conservation becomes economic for both the individual and society. (2) We need to know also the social and economic factors which cause exploitation to continue after conservation has become economic. (3) After we have analyzed the causes of exploitation, we need to evaluate the various methods of inducing conservation so that those most applicable may be used in a given situation. (4) Once a particular program is set up, we need to know whether it has achieved its objective of controlling erosion and whether it is an acceptable and economic program from the individual farmer's point of view.

All these four general problems impinge upon the individual farm, and all have wider implications of a regional and social character which may help to determine the specific plan for adoption and the social philosophy upon which a program of control or planning may be justified. The objective of this article is to outline some of the findings of a recent study of the soil conservation program on individual farms in Iowa.[2] While the bulletin reporting the study deals largely with the effect of the program, the first three problems are discussed here in order to show the close inter-relationship of all four.

Factors Determining the Point Where Conservation Becomes Economic

Under perfect competition, given such basic assumptions as complete mobility and divisibility of the factors of production, perfect knowledge and the "economic man," there would be no such phenomenon as the uneconomic exploitation of resources. Neither would there be any conflict between the social and individual point of view, since such conflicts arise only when social groups or agencies have greater knowledge than the individual and can, therefore, make wiser decisions or eliminate certain risks and uncertainties. Given perfect competition, the maximum social and individual productivity will result from the interplay of competitive forces at the margins. When land is plentiful and cheap, relative to labor and capital, it will be used extensively and very little effort or cost can be expended to conserve it. But as labor and capital become more plentiful and land relatively scarce, then more labor and capital are combined with land in a given area and conservation automatically becomes economic.

In the early days of the development of the United States, when land was very abundant, it was "economic" to exploit the land and invest capital in commerce, industry, and education. Out of this early exploitation we built our cities and industrial plants. As population increased and our agricultural land was taken up, land values rose, interest rates declined, and yet exploitation continued although conservation became more and more economic. In a given situation, the major factors that determine the level whereon conservation becomes economic are the interest

[1] Dr. Bunce is assistant professor at Iowa State College and cooperative agent of the economic research division of the Soil Conservation Service.

[2] Arthur C. Bunce. The Farmer Looks at Soil Conservation in Southern Iowa. Bulletin 381. Iowa Agricultural Experiment Station, June 1939.

rate, the rate at which exploitation is depleting the capital assets, and the increasing cost of maintaining or restoring them as erosion becomes accelerated.

In a dynamic economy of changing population, changing techniques of production and transportation, changing consumer demand and flexible prices, the individual is not able to anticipate the future with certainty. This uncertainty may lead to a conflict between the individual, to whom exploitation appears to be economic, and society which because of broader interests sees that the present values forming the basis of the individual's judgment do not adequately represent the future. Such a situation is sometimes referred to as a conflict between individual time preference and social time preference, but this is merely a rather indefinite way of stating that society, because of its broader interests, is better able to anticipate the uncertainties of the future.

In order to discover whether an area has reached the point where soil conservation is economic we would have to estimate the annual rate of *capital loss* due to erosion, the *costs* of achieving erosion control, and the *effect* of the control measures upon current income for a sample of the various types of farms found in the area. While this has not been done in the study reported, the general indications are that in the southern part of Iowa participation in the soil conservation program has been economic. For example, 55 percent of 310 farmers stated that the conservation program had increased the productivity of their farms, and over 90 percent stated that they expected the productivity of their farms to be increased in the next few years. Seventy-eight percent reported that the program had increased the value of their farms, and according to the estimates made by 172 of the farmers, this amounted to an average increase of $5.44 per acre. In interpreting these figures, the fact that assistance was given in obtaining lime and fertilizer must be kept in mind.

This study also indicates the relationship between the degree of erosion and the costs of control. Under the Soil Conservation Service program, permanent pasture on cooperating farms is to be increased by about 10 percent in the western livestock and south-central pasture areas of Iowa, and intertilled crops are reduced about 11 percent. In the southern pasture area, permanent pasture is being increased by 23 percent and intertilled crops reduced 39 percent. Similarly in the case of structures, wide differences between the areas are reported. The southern pasture area, for example, has larger acreages of the cropland terraced and has more temporary and permanent dams erected than in the other two areas. As for contour farming and strip cropping, however, the southern pasture area has a smaller acreage per farm than have the other two areas.

These differences in the program, in adjoining areas in one State, reveal clearly the fact that conservation planning varies widely as physical conditions vary. Even within one watershed wide differences between the treatment of individual farms is noticeable. In the case of the areas mentioned above, the southern pasture area has more serious sheet erosion and more gullying than have the western livestock and south-central pasture areas, and the analysis indicates that in areas where erosion has made greater progress the cost of control in terms of structures involving capital outlays is larger and the changes in land use are more drastic.

In some areas in Iowa only relatively small changes in land use, coupled with such practices as contour cultivation and strip cropping, may be sufficient to stabilize soil fertility; in other areas terracing, retirement of cropland to pasture, and longer rotations may be needed, together with still other conservation practices, in order to achieve control. This seems to emphasize the fact that we need an economic appraisal of every suggested plan for soil conservation on an individual farm or area in order to determine whether or not conservation is economic. If this is not done, we may be allocating our capital to the creation of resources which are not the most economically productive, and the same amount of money expended on other areas or on other types of resources might achieve more conservation of more productive resources.

Causes of Continued Exploitation

If conservation becomes economic as population and capital increase, we are faced with the problem of determining the factors which prevent an automatic adjustment from taking place. An analysis of the basic assumptions underlying perfect competition reveals some of the economic and social problems associated with soil conservation.

We find that in agriculture we do not have complete mobility, because a rural population develops a degree of fixity in its regional patterns and its attachments to familiar scenes. Similarly, perfect divisibility of factors is not possible, since farm sizes tend to become associated with certain typical types of enterprise and density of population. As to knowledge, we find that the majority of farmers are not aware of alternative uses for the resources, and they tend to follow a

customary method of farming. Finally, the farm unit is not purely a place of business but is also a home, and therefore considerations other than the purely economic play an important part in making decisions.

One of the causes of these rigidities is that certain institutional patterns developed during the period when exploitation was economic. For example, a type of tenure relationship may evolve, market outlets for particular products may be established, taxes for roads and schools and other public services become fixed charges, and rather stable farm units become associated with the farm buildings. Under the exploitive system these may be efficient; but as the virgin fertility is used up and erosion develops, they may act as resistances to the necessary adjustments.

Another important factor tending to prevent adjustment and the shift to a conservation system of farming may be the mistakes of the past in permitting or encouraging a type of land use which is not permanently adapted to the climatic and soil conditions of the region. For example, the use of much of the Great Plains region for arable farming has led to the present population and farm-size pattern, with the development of roads and schools, present land values and taxes, and marketing facilities for cash grain crops. In these circumstances the present institutional set-up may make it impossible for an individual to adopt conservation measures because of the costs to be incurred and changes involved, although the adjustments might be economic were there greater flexibility.

A further important factor which must be considered is the question of whether or not the individual farmer is suffering all the damages of exploitation, or whether certain of these damages are borne by other individuals or groups. Where the latter occurs, as in flood damages, the silting of rivers, reservoirs, and lowlands, or where gullies and run-off damage adjacent lands, then continued exploitation may be economic for an individual only because he does not bear all the disadvantages and damages.

These causes of continued exploitation vary greatly between regions, States, areas within a State, and even between farms in a given area. In some areas the tenure system may be the most important resistance; in others it may be farm size, and again it may be ignorance or inertia. Only as we discover what these resistances are can we apply the most strategic methods of inducing conservation.

In Iowa the tenure system, with its resulting insecurity of occupancy, and the mortgage problem have been shown to be important social factors resisting the adoption of a more permanent system of farming.[3]

The present study reveals that farmers in southern Iowa have recognized the menace of erosion for many years. Over 50 percent of the farmers cooperating with the Soil Conservation Service had noticed erosion on their farms over 15 years ago, and 27 percent had noticed it 6 to 15 years ago. Of a similar group of farmers not cooperating, 47 percent had noticed erosion over 15 years ago. In their attempts to control it, many had adopted rotations more suited to the topography of the land; some had put brush, straw, and manure in gullies and had established grassed waterways. Fifteen percent had good results in controlling gullying. The reasons given why they did not do more were: "cost prohibitive," "did not know how," "tried but failed," "did not get around to it," and "did not know how long would be on the farm."

This throws some light on the problem of analyzing these basic causes. We find lack of capital for financing changes, lack of knowledge, past failures, inertia, and insecurity. If these are important in one of the richest of our agricultural States, then they may be even more important in other areas where more insecurity and less financial reserve are dominant. The problem of conservation appears to be linked closely to the problems of farm credit, tenure, and education.

Inducing Soil Conservation

Where there are many basic causes of soil exploitation, there are numerous methods that can be used to offset them. These may be briefly classified as follows: (1) Education by means of demonstration projects, Extension Service activities, high school and college classes, and publicity releases of all kinds; (2) direct subsidies to help defray the cost of actual conservation measures; (3) indirect subsidies, such as free services of technicians for planning farms, special rates of interest on loans for conservation expenditures, tax rebates, low-cost lime, fertilizer and seed, and subsidized prices for special products; (4) laws affecting the resistances, by modifying the social conditions, such as tenure, resettlement, and educational legislation; (5) laws permitting local group action, as zoning ordinances or conservation district acts; (6) laws limiting the property rights of individuals in land, such as some zoning acts and specific regulatory acts to prevent abuses which are harmful to society; and (7) public ownership.

While the list given above is not complete, it does

[3] See Schickele, Himmel, and Hurd: Economic Phases of Erosion Control in Southern Iowa and Northern Missouri. Bulletin 333. Also see Schickele and Himmel: Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area. Research Bulletin 241. Iowa Agricultural Experiment Station.

serve to outline the large number of alternative and supplementary methods that may be used to induce conservation or control land use. Practically all are being used today, singly or in combination, by various Government agencies at different levels; and herein we find a major difficulty in the evaluation of any particular program, because not only must we estimate the program's effectiveness in meeting the basic economic and social causes of the condition we are trying to remedy, but we must also attempt to disentangle its influence from the influence of other programs which also impinge upon the problem.

For example, an important factor to be considered, when evaluating the amount of change in land use introduced by the Soil Conservation Service, is the change in land use that has taken place, on farms not cooperating in the program, because of the influence of factors other than the Service program. In the study here discussed a sample of farms not cooperating with the Soil Conservation Service was taken and the changes in land use from 1933 to 1937 were tabulated. This showed that on noncooperating farms permanent pasture had been changed very little, intertilled crops had been decreased, small grains increased, and total meadow decreased. In all areas, however, the changes in land use towards a soil-conserving system were much greater on the farms cooperating with the Service than on those not cooperating.

We should know how important these other factors have been in assisting the farmers cooperating with the Soil Conservation Service to make the needed reductions in the acreage of intertilled crops, since obviously the final effect is the result of their concurrent action. To evaluate this situation objectively appears impossible at this time. Further study certainly should be given problems such as these in order that farmers and State and Federal workers may make effective decisions.

Difficult as this problem is, it appears essential that some attempt be made to evaluate the effectiveness of all control measures in terms of their ability to affect the basic social and economic causes underlying erosion. This evaluation can be made only as we obtain more insight into the causes, the methods that may be used, their costs to society, their acceptability and their effectiveness as they are applied to relatively small areas and on individual farms.

Program in Southern Iowa

Any conservation program that is established in any particular area must satisfy two basic requirements if it is to be permanent and widely adopted over the areas where conservation is needed: It must control erosion effectively, and it must be acceptable to the farmer. To be acceptable, when no subsidy is paid, means that it must be economic from the individual operator's point of view. Again, farmers' opinions must be given an important place because it is what the farmers think of the program, and specific elements in it, that will finally determine how much of it becomes permanent and whether or not it will spread to farms outside the demonstration areas.

As to the effect of the program upon erosion, over 90 percent of the farmers report that it has been effective in reducing both gully and sheet erosion. The accompanying table gives a summary of their opinions:

Table showing opinions (by percentage of farmers reporting) regarding the effect of the program on erosion conditions in southern Iowa, 1937. Sheet erosion was reported on by 290 farmers; gully erosion, by 284 farmers.

Types of erosion	Stopped	Greatly reduced	Slightly reduced	Not reduced	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Sheet erosion	4	51	36	9	100
Gully erosion	11	58	24	7	100

This indicates that in southern Iowa the program has been quite successful in controlling erosion, according to the present opinions of the cooperating farmers. It will be interesting to learn whether the same farmers on the same farms will have the same opinions 5 years from now.

When we turn to the second question, of whether or not the program has been acceptable to the farmer, we find a much more complicated problem, with parts of the program satisfactory to all and some elements in it satisfactory. The economic effects are related to the changes in land use and the resulting repercussion on yields, the relationship of grain to roughage feeds, the livestock system, and the total and monthly labor quantities used. Only a few of the most important results can be presented here.

As was indicated previously, the farmers stated that the program had increased the productivity of their farms, and they seem to have been well satisfied with it in spite of the fact that they listed numerous specific difficulties resulting from farming terraced, strip-cropped or contoured fields. In general, the farmers would continue all the present practices and the land-use patterns introduced, without further assistance from the Soil Conservation Service, with the exception of strip cropping which would be discontinued by 27 percent of the farmers, and contour farming which would be discontinued by 15 percent of the farmers.

(Continued on p. 82)

An excavated reservoir in process of construction. The dragline is being used extensively for making dugouts. Dugouts are well suited to relatively flat terrain.

FARM PONDS IN SOIL AND MOISTURE CONSERVATION

By H. G. JEPSON [1]

THE use of ponds to supplement water supplies on the farm or ranch is by no means new. Probably the practice is centuries old. In the United States ponds have been in use as long as farming has been carried on. The increased need for this source of water supply, however, has become most apparent of late years, especially since the drought periods occurring since 1929. If an annual rainfall of 85 percent of the mean is considered as producing drought conditions, then there have been 11 major drought years in the period from 1881 to 1936; of these 11 a total of 5 occurred since 1929, namely, 1930, 1931, 1933, 1934, and 1936. In 1936 a total of 18 States recorded drought conditions, some of them extreme.

It is when several drought periods occur in close succession that water supplies dwindle. Sources that for many years had been unfailing went dry during and immediately following these repeated dry periods. This was especially true of springs, small streams, and shallow wells. In certain localities the only available water was from a few well-designed ponds or reservoirs where the impounded supplies were adequate to withstand evaporation and seepage.

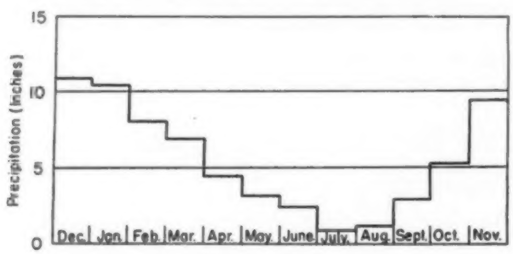
When other sources of water supply fail, the farm pond is almost indispensable. Not only is it used for livestock watering but also for domestic purposes to supplement erratic wells or the cistern—although when used in the household it is, of course, necessary to install measures to insure purity and safety. Ponds also may be used for irrigations, for recreational facilities such as boating or swimming, for wildlife such as game birds and fish, and in northern climates as a source of ice. Of the farmers and ranchers fortunate enough to have good farm ponds during the recent droughts, many when questioned declared that they could not have continued farming without them. In Montana a group of 12 ranchers when asked to evaluate their stock ponds gave estimated benefits ranging from $50 to $1,000 per year.

It is commonly thought that farm ponds are required only in the so-called arid and semiarid States. The greatest need for them is, of course, in these States; but more and more it is being recognized that areas classified as humid may have such unsatisfactory distribution of precipitation through part of the year

[1] Associate agricultural engineer, Soil Conservation Service, Washington, D. C.

that drought conditions often will prevail. Even though the total rainfall during the year may be the average or above, still there may occur two or more dry months in succession when water supplies will be depleted to the extent of water shortage. Such areas could be materially benefited by farm ponds, especially in localities where much livestock is raised.

The accompanying chart shows the average *monthly* precipitation for western Oregon and western Washington. The *annual* precipitation averages about 66 inches (about 5½ inches per month), and yet for the months of July and August the precipitation over a period of many years has not averaged much over 1 inch per month. In addition to this, the months of May, June, and September have relatively low rainfall as compared with the average monthly precipitation for the year. This condition thus allows 4 or 5 consecutive months of low rainfall during the season when evaporation losses generally are highest.



Even though in most localities the average seasonal rainfall distribution is better than that indicated in the chart, still the variation from year to year in any particular season may closely approximate such a condition. It is not uncommon in humid States, ordinarily having a monthly rainfall of 3 to 6 inches, that less than ½ inch precipitation occurs per month for as much as 2 or 3 months in succession. It is at times such as this that drought conditions prevail and sources of water supply may fail temporarily.

To control erosion, it is necessary to prevent destructive run-off of surface waters that accumulate as the result of rain, hail or melting snow. One of the best means of accomplishing this is by retention, on the drainage area, of as much run-off as possible. This is done by proper land use and approved cropping and tillage practices; and these frequently are supplemented with subsoiling, contour furrows or ridges, listing, and level terraces. Where additional run-off must be held and the terrain is suitable, considerable water can be retained by constructing dams to impound it. The reservoirs created can be utilized as farm ponds for whatever purpose is desired.

It is also possible to stabilize actively eroding gullies by converting them into usable farm ponds. This method of erosion control has been successfully used in a number of cases. Under favorable conditions it is thus possible that the farm pond serve a dual purpose by providing a water supply and at the same time controlling gully erosion. Such ponds, however, will usually silt up within a short time.

One of the most important functions of the farm pond in livestock areas is that it enables a more complete and well-balanced land-use program. Water is essential in livestock production. It not only must be available, but it must be well distributed so that livestock does not have to travel long distances to obtain it. By having several sources of water distributed over the ranch or farm unit, it is possible to rotate grazing areas and thus give depleted grassland a chance to recuperate. Only by having water available at the right places and in sufficient quantities is it possible to obtain good range or pasture management.

There is little doubt that the placing of innumerable farm ponds throughout the country will do much in moisture conservation. When it is considered that only a small pond not more than an acre in surface extent, and with an average depth of about 8 feet, will hold 2 or 3 million gallons of water, it is evident that thousands of these ponds really can conserve a great deal of water.

Types of Farm Ponds

The two main types of farm ponds are those created by:

- A. Impounding reservoirs:
  - 1. Dams.
  - 2. Levees or dikes.
- B. Excavated reservoirs:
  - 1. Dugouts, charcos, tanks, water holes, with—
    - (*a*) Natural earth or rock lining.
    - (*b*) Artificial lining.

A great many ponds are a combination of both A and B. It is common practice when obtaining material for an earth dam to excavate it from the reservoir site. Local terrain and the purpose of the pond will largely determine the type constructed. In general, it can be stated that ponds falling under A have the greater water capacity; this is because impounding reservoirs are limited to a terrain that will give considerable storage through the use of retaining structures. Excavated reservoirs ordinarily require that a cubic foot of material be excavated for every cubic foot of water to be impounded.

In an area where the land is flat and stream channels shallow or not well defined, it is difficult to find a site suitable for an impounding reservoir. An excavated reservoir is often the best solution under such conditions.

This also holds true for much of the arid and semiarid sections where evaporation losses are high. Here a deep dugout [2] with little surface exposed to evaporation is more desirable than a large pond that has much surface area exposed and considerable shallow water. To the stockman whose rangeland may extend for many miles the dugout is particularly suited. A dugout ordinarily does not involve the cost of constructing an impounding dam and, in addition, does not present the maintenance problems. This is an important feature because it is not possible to give frequent inspections to ponds that are widely distributed over an extensive area. Under such conditions a water supply that has a low initial cost and that can be depended upon with a minimum of maintenance, will be required. With reasonable care and judgment it should be possible to construct several dugouts for what it would cost to build a good impounding dam.

Experience in many places in the West has shown that large ranges often need a few big watering places in addition to numerous small ones. These big watering places help livestock through prolonged drought periods when the smaller ponds may fail, and they therefore should be strategically located if they are to serve their purpose. They enable the building up of a supply of stock water that can be held in reserve for emergency.

Another factor that may influence type of pond is local soil characteristic. Some soils have a highly impervious surface underlain by porous substrata. Under such conditions it would not be desirable to excavate a dugout because of probable seepage losses and, therefore, the impounding reservoir would be the better one to use.

Sometimes the only reservoir site available has so large a drainage area as to make impossible the economical construction of an impounding reservoir. A possible solution would be to excavate a dugout adjacent to the stream. During high-water periods most of the flood waters would be bypassed and only a normal amount diverted to the dugout.

There are many who have no need for more than a small storage reservoir and who cannot afford to construct a dam and the excavated reservoir is often the best solution to their requirements. For those who require much storage capacity, however, and who desire recreational facilities as well, the impounding reservoir is to be preferred.

Purpose and Location

Even though location of ponds is influenced by terrain, still the purpose for which the pond is to serve must receive consideration. For example, there is nothing gained by building a stock pond in a location so far removed from pasture or range land that the livestock must travel excessive distances for water. The number of watering places needed will depend on the relief of the area, the amount of forage available, and, of course, the climate and precipitation of the area. As has been pointed out, the use of grazing ground is limited by the availability of water and this water should be widely distributed; not just a few large supplies but many small ones also should be provided.

In gently rolling range territory, water spaced 3 to 4 miles apart is usually sufficient. In steep, rugged range country, water spaced about 1 mile apart is not too close. In readily accessible range areas of low carrying capacity, it may not be economical to provide watering places closer than 4 or 5 miles. For pastures where dairy cattle are kept the water supply will generally be well below these spacing limits because of the average pasture sizes. Dairy cows should not be made to travel as far for water as beef cattle. These figures are merely given as a guide and it is realized that they represent more or less optimum distribution of water facilities. However, they should be followed as nearly as is reasonably possible. Only in this way is it possible to avoid overgrazing around a few watering places and unused feed on other parts of the range too far removed from the water supply.

Extremely low carrying capacities may preclude any water developments whatever, but if the area is to be grazed at all, watering places should be provided. The location of stock water in such areas should be made primarily for protection of the vegetative cover as an erosion control measure.

It is not good practice to build a reservoir for domestic or stock-water supply in a location where the barnyard will drain into it. Such drainage may lead to serious contamination and at the best would produce undesirable conditions in the water supply. If the prime purpose of the pond is erosion control, then location is of course limited to the problem area. It is always desirable to locate a pond so that it will have a protected drainage area. Actively eroding and unprotected drainage areas should be avoided if possible.

[2] The terms dugout, charco, water hole, and tank mean one and the same thing.

An active gully head before control work was undertaken.

Other requirements, such as for irrigation purposes, have marked influence on location. Terrain or the pumping costs often are such that for economical irrigation the pond must be located near the field to be irrigated. Other locations, even though more satisfactory from a construction standpoint, would therefore be unsuitable.

Once the general location of the proposed pond has been decided upon, in best conformity with the purpose for which the pond is intended, it then becomes necessary to make a more detailed survey of the area. The larger washes, particularly those through which great volumes of water rush in times of flood, are to be avoided in the construction of ponds. Each location should be carefully examined and compared with others available before final selection is made. A detailed study will often reveal undesirable characteristics in a site that on casual investigation may have appeared satisfactory. Some of the factors which should be considered in selecting a reservoir site are here pointed out:

1. *Location with respect to purpose of the pond.*—The final site selected should be in accord with the use that is to be made of the reservoir. For example, where ponds are used for stock-water purposes, they must be spaced over the range to obtain wide distribution. Many little ponds will be required, and the number of large deep reservoirs should be restricted to the minimum. The very number will necessitate that they be of low cost. Natural spillways [3] must be used to keep down costs, and choice of site should thus go to locations where a natural spillway is available. Where a favorable site for a dugout is available it would ordinarily be selected in preference to one requiring the construction of a dam.

2. *Possible storage capacity and depth of the reservoir.*—These should be considered from the point of view of the required size of dam or amount of excavation. Generally it is desirable to insure a large amount of reservoir capacity in proportion to the size of dam required or the amount of excavation needed. A large storage capacity, however, is not always indicative of a desirable reservoir. Frequently it is found that large capacity can be obtained on wide, gentle flood plains, but that the reservoir itself will have an excessive amount of shallow water; such a reservoir might be undesirable because of evaporation losses. Final choice would thus go to a deep, relatively small reservoir that has little surface area exposed to evaporation.

The recent drought periods have evidenced that in many instances farm ponds have been provided with insufficient depth to offset evaporation losses. It is not always realized that evaporation may be most severe during a drought year. In certain localities the loss in some years may be as much as 7 or 8 feet. This is sufficient to nullify completely the capacity of an average pond if no replenishments ensue. It is felt that in general the farm pond should have a minimum depth of 8 feet in subhumid areas, 10 feet in semiarid, and 12 feet in arid sections. A 6-foot minimum depth should be provided in humid areas.

3. *Drainage area contributing to reservoir.*—Size, shape, slope, and cover should be investigated. The drainage area is an important factor in the selection

[3] Natural spillways are assumed to be drainageways requiring no further excavation, and in which the native sod is utilized.

The same site a year later. An earth dam has impounded the water. The spillway crest has been made sufficiently high to prevent destructive action at the gully head.

of the site. It must be sufficiently large to maintain the reservoir water supply even during years of drought, and yet not so large as to present a constant flood menace to the pond. The area must not be actively eroding, else silt will nullify pond capacity in a short time.

Experience seems to indicate that the minimum drainage area required, in acres per acre-foot [4] of pond capacity, will be for average conditions from 3 to 6 for humid areas, 5 to 30 for subhumid, 25 to 60 for semiarid, and 50+ for arid. The seemingly wide range of figures merely indicates that local conditions influence the size of drainage area to be selected and that no set rule can be given that will apply equally to any and all conditions.

4. *Type of soil.*—It is well to check carefully the soil on both the drainage area and the reservoir site. A porous soil on a relatively flat and well-vegetated drainage area may mean insufficient run-off to supply the pond. Certain soils are also unsuitable for reservoir sites because of seepage losses.

5. *If dam is to be constructed, foundation, fill material, and spillway possibilities should be considered.*—In many instances no natural spillway is available and if a mechanical spillway is too expensive to construct the site must be abandoned. In some localities it is impossible to find suitable fill materials for earth embankments or proper aggregate for masonry structures; this may become a deciding factor in choosing a site. For small earth dams, foundation conditions may be generally satisfactory, but may involve certain difficulties such as porous strata of shale, gravel, sand, or even peat.

[4] An acre-foot of water is the equivalent of water spread uniformly over 1 acre of surface to a depth of 12 inches.

An item often overlooked in the design of a farm pond is protection of the reservoir against silting. Numerous examples might be cited, in all sections of the United States, of reservoirs partly or completely filled with silt. In certain instances complete silting of the reservoir has occurred within a period of only 2 or 3 years. Many reservoirs have only one-half to one-fourth of their original capacity because of silting. Frequently the owner of the pond is entirely unaware of the extent or seriousness of silting until most of the reservoir capacity has been destroyed.

The best protection against silting is attained by selecting a pond site that receives run-off from a drainage area on which erosion is under control. Cultivated, overgrazed and burnt-over lands all contribute considerable silt to surface run-off and should not be utilized as the primary water source for farm ponds unless nothing else is available. A drainage area consisting of woodland, meadow, or pasture is much preferred. Good land use thus enters into the design of farm ponds in that it is essential in protection against silting.

Where only actively eroding drainage areas are available it is suggested that erosion-control practices be installed and placed in operation for a period of at least a year or two before the pond is constructed. A practice frequently used for silt protection is that of placing a border strip of close-growing vegetation along the upper part of the pond. This border strip is so placed that all run-off water from the contributing drainage area must filter through it before reaching the pond. These protective strips should have a width of at least 200 feet and, preferably, more. They should be established before the pond is constructed. This type of silt protection is generally the most economical

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in areas where vegetation can be established. It is desirable also to establish a growth of woody plants in the strip, as they are more effective than grass in contributing to desilting during heavy run-off.

Another practice that is sometimes used, especially where large drainage areas are involved, is that of designing the reservoir so that the major part of flood run-off is bypassed and only a small part diverted into the pond. In this way most of the silt-laden waters will not have opportunity to deposit their load in the reservoir. When only a small amount of run-off occurs it will all be diverted into the reservoir.

Wildlife

With little additional effort a farm pond can be converted into a wildlife habitat that will be a source of pleasure and sometimes a source of income to the owner. This holds true primarily for the impounding reservoir; but on rangeland where large numbers of widely scattered dugouts are used it is not always economical to provide the full protection desirable for wildlife.

Many States, including most of those in the West, have laws regulating the construction of dams beyond a certain height or the impounding of water for storage purposes. Even in the States where no permission is required to store water, the natural flow of surface streams must not be changed to the injury of owners of riparian tracts farther downstream. Should such injury result, the builder may become involved in costly damage suits.

In the malaria sections of the United States the Public Health Services generally have certain restrictions on water storage in open reservoirs. This is necessary in order to control the mosquito that acts as carrier of the malaria germ.

Since no two States have precisely the same laws and regulations affecting construction of dams, water storage and water rights, it is not feasible to summarize them here. Furthermore, such laws and regulations are continually being changed or altered. It is suggested that, wherever construction of a reservoir is contemplated, inquiry be made through local authorities as to possible restrictions.

SOME ECONOMIC AND SOCIAL PROBLEMS OF SOIL CONSERVATION

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In the case of structures such as terraces, permanent dams and diversion ditches, most of the farmers stated that they would not erect them without assistance.

This indicates that certain parts of the program may be generally accepted while some parts, especially those involving large capital outlays, may not be accepted without some form of subsidy.

The effect of the program has been to increase the quantity of roughage feed and, in most instances, reduce the quantities of grains. The increase in roughage will be used to reduce overgrazing during the dry summer period; some will be plowed under as green manure, and some will be used up by feeding a larger number of roughage-consuming animals. There was no indication that a smaller number of hogs would be raised, and the study indicates that the number of hogs raised on any farm was not correlated with the percentage of the land in intertilled crops but was correlated with the amount of feed bought and sold.

No final conclusion can yet be reached regarding the effect of the program upon the net farm income. Bulletin 381 outlines the factors to be considered by each farmer when he must make a decision whether to adopt or not to adopt a conservation program. In general, the study indicates that in southern Iowa conservation is economic, that the soil conservation program is effective in controlling erosion and that it has largely been accepted by the participating farmers as a permanent system.

CUTTING AND USE OF BRUSH IN EROSION CONTROL

By J. W. DEPPA [1]

BRUSH pruned from piñon and juniper stands has been used extensively to control erosion. Every conceivable type of brush structure has been built, ranging from thin mats to huge piles of brush placed as dams in gullies or in water spreading systems. That part of the following discussion which applies to the silvicultural aspects of brush cutting from live trees refers only to the piñon-juniper forests of southwestern United States.

In obtaining the brush, various cutting methods have been followed. A cutting system often used consists of lopping off all basal branches with axes, although experience has shown that saws in the hands of trained men can result in as good production with less personal danger involved. The use of saws also leads to better cutting practices.

Cutting all the basal branches from a tree exposes the accumulated litter and duff to excessive drying and to removal by wind and water. Thus serious damage may result on steeper sloping areas and places where the grass cover does not adequately protect the site from erosion. On trees primarily valuable for watershed protection, great care should be exercised to avoid reducing their effectiveness. Where the trees are on steep or eroded hillsides, the removal of branches which provide soil protection could scarcely be justified, no matter how scientifically the brush might be used in stopping erosion at some other place.

Conservation work, including brush cutting, ought to lean toward conservation practices. Brush cutting might well be done by what is sometimes called the "concealed cutting system." This method yields considerable brush without jeopardizing the production of posts, in the case of juniper, and may safely be used on potentially erodible sites simply by reducing the intensity of the pruning.

From one-tenth to one-fifth of the tree crowns may be removed without significant reduction of ground cover effectiveness and without appreciable damage to the vitality of the trees. Emphasis should be placed on the preservation of those branches nearest the ground, as they are especially valuable in preventing loss of litter and duff from beneath the trees. This litter and duff accumulating under the trees often preserves the only organic and permeable soil remaining on many sloping areas.

A concealed cutting removed a compact pile of brush 4 feet high from the tree behind. A 12-foot pole saw was used. A somewhat shorter handle and a stiff and fairly coarse saw is also practicable. Note that the basal branches have not been disturbed. Under some site conditions, even more brush could be taken.

Brush has several characteristics which govern its proper use. It is somewhat temporary in nature, light in weight, and makes a permeable construction material. Its relationship to vegetative growth which may be covered in construction, or which may be planted or appear later as volunteer growth, is especially important, since the brush may assist the vegetation or damage it according to the density of placement.

Using brush in the construction of large and solid structures should be the exception, rather than the rule, because brush, no matter how carefully placed, only retards flowing water; it seldom packs tightly enough to prevent all undercutting. If a thick brush gully plug is placed in erodible soil, it will almost invariably be cut under or around, leaving the brush work high and dry. Any slight impounding effect which the plug then may have will only tend to build up a head of water that will cut previously made holes deeper and larger. In a soil that resists erosion, such as

[1] Soil conservationist, Soil Conservation Service, Albuquerque, N. Mex.

decomposed granite or other rock, a fairly large porous plug may seal tightly and cause complete filling of the dam, but the net benefit of such work is debatable The governing fact is that brush disintegrates within a few years at most, after which time the silt bed formed may be entirely or partially destroyed.

A 2-inch deposition of silt will show that erosion has been stopped just as conclusively as a 2-foot layer. Anything above a minimum fill is in the nature of reconstruction, which, although often justifiable, in most cases might be left to the more gradual but infinitely more permanent development of a vegetative retardant that can be established just as well or better on fills inches deep as on unstable deposits several feet deep behind shaky brush dams.

Instead of stopping erosion by sheer mass of construction, it is suggested that in most instances the job of control and rebuilding be modeled after the age-old processes of nature—filtering muddy water through vegetative growth, dropping that portion of the silt content which can remain on a stable plane permitting natural vegetation. The process is repeated indefinitely in nature, and although losses as well as gains occur, the natural healing method can be successfully imitated.

Because it is impossible permanently to maintain brush structures, they must serve their purpose before disintegration occurs. We believe that, ordinarily, plans should be drawn so that the brush structures will convert or metamorphose into vegetative structures capable of taking over and continuing the healing process. Many types of brush structures not only cannot meet this requirement, but all too often kill vegetation already established. The solution is to use brush of a type and in a manner that will meet the requirements of plant growth rather than of engineering design.

In a region such as the Southwest, site conditions often are unfavorable to vegetative growth, and barren spots are covered very slowly, if at all. This is largely due to the high soil temperatures, the beating effect of heavy rains with resultant erosion and the cracking and heaving of the soil surfaces. In addition, such exposed sites offer no protection against the activities of rodents and birds always alert to pick up seeds.

Brush scattered over such places will give protection to struggling vegetation in much the same way as lath shades in a plant nursery or burlap cover on new lawns. It will reduce the intensity of the sun's rays and retard evaporation by shading and by reducing wind action. As needles or leaves drop from the brush, which should be green when placed, a diffused mulch will form on the bare soil. Equally valuable are the resultant reduction of soil movement or erosion, the retention of water, and the deposition of layers of silt during storms. These layers should not be so deep as to overwhelm seeds or seedlings or established vegetation.

Too much brush laid over a planted area, or one having some native vegetative growth, would act in the same manner as complete shade over a nursery, or an impervious covering over a new seedbed. Not only would it prevent the development and growth of new plants, but it would kill or devitalize any plants already present.

In an experiment which was set up to determine the influence of brush on the growth of natural vegetation on barren areas, it was found that in 1 year's time a light covering of brush resulted in much heavier vegetation than that on check plots with no brush covering. On one plot, 6-weeks-old grama developed to two and three times the height of the same species on an unbrushed plot. Growing through the brush the grama produced large seed heads, whereas without the advantage of the brush the seed heads were not equal in size or profusion.

Recent brush work done in the Rio Grande watershed has shown a number of contrasts between light and heavy brush work. In one particular area thousands of square yards of thin brush mats were laid down, and they have shown strikingly that only a very small amount of brush is necessary to cause an appreciable dropping of silt and other debris, thus greatly improving the habitat for plant growth, especially for the grasses.

It often has been argued that light brush work cannot withstand heavy flows of water, and that heavier plugs weighted with rock or tied with wire should be used instead. However, gullies which are too large to be controlled with simple brush mats with an occasional small anchoring, are usually too large to be worked with brush. There seems to be little point in accumulating a mass of silt unless definite provision is made to secure vegetative growth within the life of the brush, which growth will prevent the silt from continuing its progress dowmstream.

As to the method of laying brush, there are those who advocate placing the tips of the brush upstream, others who argue that the tips should be placed downstream, and yet others who say that it makes no difference. The method of laying is not vital in all instances, although if a satisfactory mat is to be placed

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Erosion-Control Lessons From Old-World Experience

I. STRIP CROPPING BY INHERITANCE IN FRANCE

By W. C. LOWDERMILK

ANY TRAVELER in rural districts in France is likely to be impressed by the general evidence of cropping in narrow strips. But the strips run up and down slopes as well as across slopes and the practice is not a feature of purposeful or planned erosion control, but is the outcome of repeated divisions of land under the laws of inheritance. These old laws constitute a serious burden on efficient agriculture in France.

During feudal times large tracts of land were held by lords, dukes, and landed gentry. After the revolution their properties were divided equally between heirs of successive generations who in turn divided them into smaller parcels to their multiplying offspring. Only limited numbers of the old, large ownerships are left which have not thus suffered repeated subdivision.

When a large land holding is thus divided and subdivided, in a few generations, into literally thousands of small parcels, with each owner or occupier attempting to farm his land in several narrow strips, the problem of efficient agriculture is serious. Sometimes the strips are no more than 10 feet wide and are hundreds of feet long.

The first consideration in a division of land for separate heirs is access to the serving road to avoid trespass and to assure rights of use. Division must be along the serving road, and in only one dimension, and thus in time a tract of land is parceled into bands of narrow strips or ribbons. The land of a proprietor generally consists of many narrow strips separated by other ownerships. Liberty in the use of his land is limited by size, practices on adjoining strips under other ownerships, and by scattered location of separate strips. Strips as narrow as 10 feet and in extreme cases no wider than wheel tracks may run back from the road for hundreds of feet, approximately at right angles to the road.

If the serving road runs along the valley, strips bordering the road run up and down the slope; if the road is up the slope, strips run across the slope. In the latter case many years of plowing strip fields as separate units across the slope has produced a "benching" of the land, and this has proved a most effective means of erosion control on the steeper cultivated slopes. A bordering hedge is most effective in benching the land. The origin of benching is under discussion; some claim it was done by hand labor, others contend that it has been produced gradually under plowing.

Rural land-ownership maps show almost unbelievable subdivision. A map of the Commune de Quevilloncourt shows how an area of 214 acres is subdivided into 815 separate parcels of land, owned and operated by 105 different farmers. In the Commune of Davanescourt an area of 380 cultivated acres is divided into 1,349 strip parcels. In the Commune of Malmy an area of 214 hectares (505 acres), under 47 owners, exists in 750 parcels. In the territory of Avancon an area of 1,609 hectares (4,022 acres) lies in 3,608 separate strip parcels. In the Department of Ardennes, a survey by the Direction of Waters and Rural Engineering disclosed that an area of 48,688 hectares (120,720 acres) in 8,619 ownerships comprises 179,818 separate parcels of land. Excessive subdivisions of the land by laws of inheritance are not exceptional but are general, and for this reason place a heavy burden upon French agriculture. A few larger ownerships remain intact or in larger tracts, and there is a tendency for owners to buy up adjoining parcels to block out sizable farm units, but this is a slow process.

In 1919, so serious had become the problem of using land thus minutely divided that government action was necessary. The act of May 4 of that year was passed to place the services of the Direction of Waters and Rural Engineering at the disposal of farmers who would form syndicates for the consolidation of their holdings, for adjustment of boundaries, and for the relocation and building of additional serving roads. This service has become one of the major activities of the Direction of Waters and Rural Engineering. The law provides a service to farmers who wish to take such action. No coercion is attempted, for French farmers are a highly individualistic group, tied to the land and customs of their fathers. The Director of the Agricultural Services for the Province, an official similar to our State Director of Extension, publicizes the provisions of the law and informs and assists landowners in forming syndicates of farmers for consolidation of their holdings. While considerable action has been taken,

it by no means solves the problem of parceled land. Many agricultural authorities consider the act insufficient to the needs of the situation; yet the accomplishments to date are important.

Out of a total of more than 121,720 acres treated under the act, 179,819 separate parcels originally existed under 8,619 owners. Consolidation of parcels and adjustment of boundaries reduced this number to 38,136 holdings. To serve these adjusted tracts, the Direction of Rural Engineering built more than 500 miles of new roads. When a block of land containing many parcels and owners is similar in character, the advantages of larger tracts are sufficient to induce farmers to get together for the purpose of land-boundary adjustment and consolidation. In the Commune de Quilloncourt area of 380 acres of 105 owners, the 815 parcels were consolidated into 216 parcels. In the Commune of Davanescourt, of 380 acres, the 1,349 parcels were consolidated and reduced to 64 separate holdings.

An interesting example of consolidation is that being carried out by a Mr. Schlumberger of Alsace in the upper Rhine Valley. His estate of 275 acres, in vines, is a consolidation of 3,030 separate parcels. These vineyard properties are on slopes varying from 20 to 45 percent. Mr. Schlumberger is proceeding with a program to change the direction of vine rows, from up-and-down the slopes of former narrow strips to contour rows. He is constructing retaining walls on the contour with concrete outlet channels and storm drains. He gradually fills in the valleys so that the former drainage channels of the slopes are eliminated. Thus he has entirely transformed the area into contour cultivation and terracing for soil and water conservation and erosion and run-off control.

The people of these vineyard sections are alive to the damages of erosion and storm run-off, but there is little for a man to do who possesses a parcel only 10 to 15 feet wide, extending several hundred feet up a steep slope, unless he builds rock terrace walls or joins a syndicate for the readjustment of holdings. So individualistic are the land owners of this section, however, that the latter move is unlikely for the present. Thus these small strips running up and down the slopes have resulted in serious erosion in the vineyards of Alsace because of lack of coordinated effort and efficiency.

Up until the World War, cultivation was almost entirely done with the hoe. The irregular surface and piles of cut weeds left by hoeing were a deterrent to erosion on the up-and-down strips. Since the World War, horse-drawn cultivators have been used and they greatly accelerate erosion because of the formation of cultivation furrows up and down the slopes. At Kaysersberg there is a channel, 18 by 18 inches, which was sufficient to carry away the run-off under the condition of hoe cultivation. But now, after heavy rains, the current overflows the former channel to a width of 10 feet and to a depth of more than a foot, and then sweeps down the road, carrying destruction whenever it flows across fields and vineyards.

The solution, of course, is the consolidation of land ownerships by exchanges and purchases, and the building of additional service roads. Strip cropping has been forced upon France under the laws of inheritance, and one gets some conception of advantages that would result from a general use of such practices were they designed especially for the purposes of erosion control and soil conservation.

CUTTING AND USE OF BRUSH

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the brush should be handled more or less as individual pieces rather than as piles or bunches.

A given amount of brush will offer more resistance to stream flow if the tips are placed so as to point upstream. It is the baffling effect of the brush which slows up the water and causes deposition of the debris; therefore, the greatest retardation per unit of brush will be secured by the upstream tip placement. A brush mat can be made rapidly and well by thrusting the butts of the pieces into the tips of brush previously laid, working in an upstream direction.

Ordinarily, in placing brush in a gully, if the gully is not too large for this type of work there should be little danger that the brush would be rolled into a jam or moved appreciably by the flow of water—this, since the immediate action of a flow of muddy water encountering a brush mat is to drop the heaviest part of the silt load, thus anchoring the brush. This effect practically is positive if the mat is so thin that it does not offer too much resistance to the flow of water. If brush is to be used where there might be danger of movement during storm periods, it would be advisable to weight the brush or use wire ties of the butterfly type for anchorage. In instances when anchoring is not practicable, and larger flows are feared, the butts of the branches might well be placed upstream to lessen the resistance to the flow.

From the woodland point of view the manner of obtaining brush from the tree is more important than the method of its placement, since the living and growing branches if left on a tree often may have

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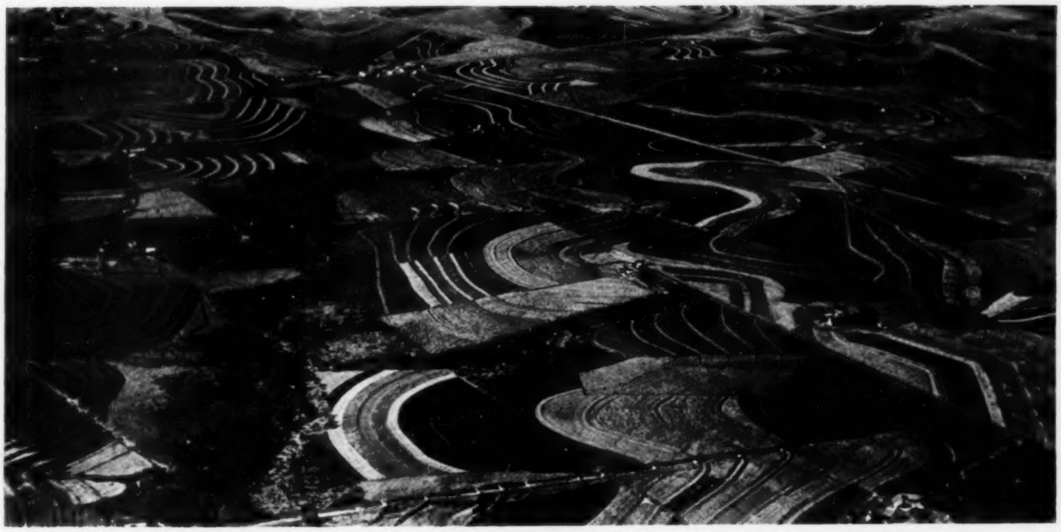


A solid block of farms in the Wilson Hollow watershed under a single scheme of conservation practices. A clear depiction of the advantages of watershed planning without regard for property lines. The terraces continue from one farm to another without a break. Cooperative channels are used. Wilson Hollow is a tributary of North Elm Creek.

FARMER COOPERATION IN THE BLACKLANDS OF TEXAS

By WILLIAM H. WITT [1]

DOWN in the Blacklands of central Texas is one of the Nation's largest blocks of conservation-treated land—165 farms covering 30,000 acres. Farmers here are ready to set up one of the State's first soil conservation districts. Petitions from farmers in Bell, Falls, McLennan, and Milam Counties have been submitted to the State Soil Conservation Board—petitions requesting the formation of the Central Texas District, covering 750,000 acres.

The story behind today's outlook reveals an important fact: farmer cooperation made such an achievement possible. The rapidity with which central Texas farmers set machinery into motion for the establishment of a soil conservation district under the new State law, signed by the Governor late in April, indicates that these men want to see the 30,000-acre block lengthened and broadened to 750,000 acres.

When the Soil Erosion Service project was established at Temple in 1933, to assist farmers in Bell, Falls, McLennan, and Milam Counties in demonstrating the practical control of erosion, the work area was designated as the 206,000-acre watershed of Elm Creek. This watershed includes Little Elm, Big Elm, South Elm, and North Elm Creeks. The first work was started in Big Elm watershed in December 1933.

Farmers in the entire Elm Creek drainage basin knew before, or shortly after the conservation program was started on the upper reaches of Big Elm, that erosion control was to be undertaken on a watershed basis—beginning at the crest of the divide and working down, farm by farm, until the banks of the stream were reached. They were interested and they made it their business to find out what was going on.

Among the men who closely followed the activities in Big Elm were certain key farmers in North Elm. They had long recognized the presence of a serious erosion problem. Some of them had farmed the Black Waxy prairies for many years. They had seen the coming of the railroads in 1881 and the rise of "King Cotton," in whose wake came devastating erosion. There were men among them who remembered the stories their fathers had told of the original Blackland Prairie and its covering of long and short prairie grasses, principally the bluestems. This area, frequently referred to as "the land as fertile as the Nile Valley," originally was ranching country and it was

[1] Assistant information specialist, Soil Conservation Service, Fort Worth, Tex.

not until after the War between the States that cotton was planted on the uplands—cotton which soon became the principal crop. With the advent of the railroads came new outlets for marketing cotton, and more settlers to plow up the prairies and plant "white gold," in up-and-down-hill rows.

These men of the Blacklands had seen erosion skim off precious layers of rich black topsoil and watched with growing alarm the appearance of light colored patches on their fields—evidence that the productive soil layer was going down the creek at a rapid rate. Crop yields had declined, year by year, and overflows were becoming increasingly damaging to croplands as streams became clogged with silt. They had tried to control this loss, but they needed help.

Early in 1934 these North Elm leaders took their problems to Service technicians. The first delegation explained that North Elm farmers were interested in the same kind of assistance that was being given to Big Elm farmers. They said they believed that most of the farmers in their watershed wanted conservation systems on their farms. Service technicians assured them that assistance could be extended to North Elm if at least 90 percent of the farmers in the watershed would cooperate so that an effective watershed demonstration could be put into effect. Technicians agreed to attend community meetings called by the farmers and explain the soil-conservation program.

The meetings were held and leaders in each community selected a committee to assist in interviewing farmers. Committeemen immediately went into action. Each carried a petition which requested the Soil Erosion Service to assist North Elm farmers in the establishment of conservation practices. The signer agreed to cooperate by putting conservation practices on his land. Key farmers made flying trips over the watershed by horse, wagon, or automobile, or afoot, visiting neighbors and urging that they join the movement for watershed control.

By the middle of June 1934—only 2 weeks after leaders started circulating their petitions—242 farmers owning or operating 37,000 acres of land in North Elm had signed up. The 90-percent stipulation had been met in 2 weeks. There are 267 farms and 41,000 acres in North Elm.

The petitions were handed to Service representatives in Temple and plans were made to give assistance to North Elm farmers as rapidly as possible. Community meetings were held at which farmers organized soil conservation clubs. Members assisted the Service technicians by explaining the details of the program to other farmers and in obtaining signed agreements setting forth both the Government's and the farmer's contribution to the erosion control program for each farm. Technicians attended community educational meetings and explained the program. These clubs which served such a useful purpose in the early stages of the work later merged to form the voluntary soil conservation association.

Erosion control planning for the area was based on the watershed, without regard to farm or county boundary lines, since the area lies partly within the counties of Bell, Falls, and Milam. The planning of several farms as a single unit speeded up the work and simplified the preliminary procedure—thereby reducing planning costs. The first agreements entered into by the Service and farmers covered 34,000 acres—29,178 acres of which were in one solid block of 165 farms, representing a land area of nearly 45 square miles. Later additions of land brought the solid block's size up to 30,000 acres.

Another solid block in the North Elm watershed, but outside the 30,000-acre area, is composed of 16 farms, covering 2,578 acres. Every farm in this smaller block also is protected against erosion by soil and water conserving practices.

Actual control work on 150 farms was started early in July 1934. Service technicians assisted farmers by making individual farm plans, laying off lines for contour rows, strip crops and terraces, designing outlet channels and by furnishing small fresnos and graders for excavation and construction work. The farmers constructed the terraces and outlet channels. Two-thirds of the cost was borne by the farmer and a third by the Government. In order that all needed supervision could be furnished individual farmers, key men—usually those who had helped to organize their respective communities for erosion control—were selected to work with their neighbors and aid in the proper installation of erosion-control practices and structures.

The original work in this solid block was similar to that being done in States having operating soil conservation districts. The incentive for the initiation of an erosion-control program came from farmers, and most of the actual installation work was done by farmers. Thus, the complete conservation systems in operation on North Elm farms stand today as monuments to farmer cooperation.

Twelve cooperative terrace systems, serving 35 farms, in which terraces cross 2 or more farms without a break, are in operation in the solid block. Each of 6 terrace systems serves 2 farms; 4 serve 3 farms each; 1 serves 4 farms, and 1 system serves 6 farms.

One hundred farms are involved in 42 cooperative terrace outlet channel systems that drain water from 2 or more farms. Each of 32 of these channels serves 2 farms; 8 serve 3 farms each; 1 handles the water from 5 farms and another drains water from 6 farms.

By working cooperatively and permitting terraces from one farm to extend across the farm boundary on to the adjoining farm, or farms, the farmers have been able to omit entirely some terrace outlet channels that would have been constructed and maintained if each farm had been planned as a separate unit. This naturally reduced the amount of work each farmer had to do in excavating and sodding for establishment of terrace outlets and outlet channels.

Where cooperative drainage systems were installed, all farmers involved entered into formal drainage agreements to ensure protection of the rights of each and to perpetuate the system.

Utilization of all land on the farms for some profitable purpose was emphasized in connection with the establishment of conservation systems on North Elm farms. This principle was put into practice by the fencing of natural drains used as outlets for terrace water or of constructed outlet channels, so that they could be used as pasture. In some instances it was discovered that fields were so situated that a planned outlet channel could not be utilized by the farmer because of its inaccessibility to the regular pasture. Here a cooperative plan was worked out with an adjoining farmer making it possible to extend terraces across the farm boundary to a channel so located that it could be properly utilized as pasture. Grazing rights were defined, and stipulations regarding the use of cooperative channels or other drainageways were included as a part of drainage agreements so that proper maintenance of channels could be guaranteed over a period of years.

Where terraces meet on farm boundaries, a joint outlet channel is used, each owner giving half of the land needed for the channel. This results in the most practical utilization of the land, the most economical outlet control and maintenance. One farmer may be permitted to use the channel for grazing in return for maintaining it, or two or more farmers may pool their time and labor to ensure proper maintenance.

An excellent example of the spirit of cooperation which predominates in North Elm is to be found on the farms of Anne and Ella Frerichs, F. J. Neinast, and Mrs. John Kahler. These three farms are located one above the other on a long slope, the Frerichs farm being at the top of the divide and the Kahler farm on the lower end of the slope next to Wilson Hollow into which drainage water from all three farms flows. The three farms comprise a small interior watershed, and plans for the installation of conservation systems treated the three as a single unit without regard to property lines. A draw, which cut through the three farms from the divide to the creek, was utilized for the construction of a terrace outlet channel into which terrace water from all three farms would empty. All terraces on the three farms cross property boundary lines without a break and stretch in an unbroken line to the channel.

The drainage agreement which was entered into by the owners of these farms states that the owners agree to permit terrace run-off water from the neighboring farm to flow across farm boundaries, enter terrace channels on either farm, and flow through the cooperative outlet channel to the natural drain. By this agreement Anne and Ella Frerichs were permitted to estabish conservation practices on their land. Without the cooperation of the two owners on the lower end of the slope the operators of the Frerichs farm would have been confronted with a serious problem in locating a proper outlet for terrace drainage water. Similarly, the Neinast and Kahler farms could not have been treated until conservation practices had been installed on the Frerichs farm. Uncontrolled run-off from an untreated Frerichs farm would have made conservation practices on the Neinast and Kahler farms of little value. In this instance all three owners have joint responsibilities in maintaining the outlet channel. Each owner agrees to maintain that part of the channel located on his farm.

Channel maintenance and the use of the channel for grazing is included in the drainage agreement entered into between two other farmers in the solid block who have a cooperative channel—A. A. Winkleman and Frank Monroe. The two farms are situated one above the other on a slope, the Winkleman farm being at the top of the hill.

A cooperative terrace outlet channel has been constructed on the boundary between the farms. Under the terms of the drainage agreement Mr. Monroe is permitted to utilize the channel since it connects with his pasture. Inasmuch as the channel is located at a distance from the Winkleman pasture, Mr. Winkleman has been glad to permit Mr. Monroe to use the strip as pasture. In return, Mr. Monroe maintains the channel.

Mr. Winkleman has this to say about the cooperative arrangement: "I think watershed planning saves work and maintenance because the run-off water goes where it is naturally supposed to go. By cooperation the

work and expense is reduced to a minimum. I think a cooperative channel that can be utilized by one of the cooperating farmers is a good idea. Since the channel which Mr. Monroe and I use is located on the back of my farm, away from my pasture, I can't use it. And since Mr. Monroe can use it as extra pasture, I am glad to have him do so since it makes it unnecessary for me to do the work which would be required to keep the channel from silting."

And other farmers of North Elm are enthusiastic about cooperation and watershed planning. Bartle Crennan, for instance, says: "William Hoff, who has a farm above mine on the slope, has helped me solve a major control problem. I had been having trouble keeping my terraces maintained due to the fact that I received run-off from the Hoff farm. When Mr. Hoff terraced his fields, my terrace maintenance problem was solved."

Mr. Hoff's side of the story is also interesting: "When Mr. Crennan permitted me to empty terrace water from my fields on to his pasture it saved me the expense of constructing an outlet channel on my land. It not only saved the cost and work of constructing the channel but it saved me the land the channel would have occupied and the work I would have had to perform to maintain the channel. I think cooperation between farmers in erosion control work is necessary if the best job is to be done."

Some farmers whose lands are located on lower ends of slopes have been responsible for convincing their neighbors on the upper slopes that they too should adopt conservation practices. In most instances, treatment of lower lying farms was delayed until all farmers on a slope had decided to work together in establishing an effective erosion control program. The farmers "on the hill" quickly recognized that it would be impractical for their neighbors on the lower reaches of the watershed to apply erosion control practices if those above failed to control soil and water.

Visitors who come to Temple from all parts of the world to see this agricultural development are impressed with the modern farming picture they find. Standing on some of the highest points in the area one may look out over conservation-treated farms extending as far as the eye can reach. Terraces stretch in unbroken lines across the slopes. Rows of cotton follow the contour across the slopes, and interspersed between these row crops are erosion-control strips—small grain, sorghum, Hubam clover, and bluestem grasses.

Cooperating with nature and with each other, Elm Creek farmers are saving for posterity the nation's most priceless asset—the soil.

EDITOR'S NOTE.—The total area under agreement in the Elm Creek project demonstration covers 82,000 acres in 613 farms, including the 30,000-acre block in North Elm. This area includes conservation-treated land in North Elm and Big Elm watersheds.

HUBAM CLOVER IN THE TEXAS BLACKLANDS

By C. H. BATES [1]

AN APPRECIABLE reduction in the productivity of soils as a result of depletion of organic matter and other plant food elements has been observed throughout the Black Waxy Prairie of Texas. The loss of these materials has been the consequence principally of progressive, unhampered erosion and continued removal of crops, chiefly cotton. Agricultural leaders point to the decline in average yields of cotton over the area as an index of the productivity trend for the Blackland farms.[2]

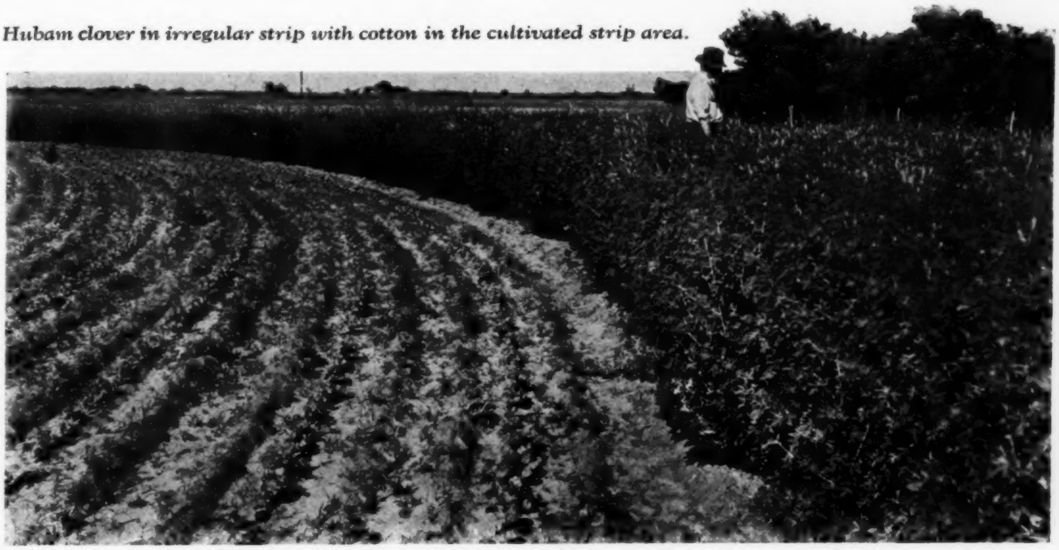
Figures from a farm business survey made in 1934 by the Soil Conservation Service, on 291 farms within and adjacent to the Elm Creek watershed area, show that cotton occupied 64 percent of the total cropland, corn 20.4 percent, and other clean-tilled crops such as forage sorghums and Sudan 4.5 percent. These figures indicate that slightly less than 90 percent of the crop area on farms of this section was in clean-tilled crops. Such cropping practice makes difficult the adoption of an effective system of rotation. For this reason the supply of organic matter has been rapidly depleted, with very slight chance for renewal during normal cropping operations. This loss due to continuous cropping, plus the damage from run-off, continues to "eat away" the remaining portion of the originally deep and fertile layer of topsoil.

The Soil Conservation Service demonstration projects (located at Temple, Garland, and Lockhart) within the Blackland region have encouraged the adoption of crop rotations and certain other soil-building practices. Because of attacks upon most legumes by the cotton root rot fungus, these crops have not been very generally used as soil-building agents in the Blacklands. Some farmers near Marlin,

[1] Associate agricultural economist, Soil Conservation Service, College Station, Tex.

[2] The reduction in total acreage planted to cotton during the past few years has doubtless affected the recent trend as compared to previous periods. C. H. Bates: unpublished manuscript, 1939.

Hubam clover in irregular strip with cotton in the cultivated strip area.



in Falls County, Tex., for a number of years have planted Hubam clover (*Melilotus alba annua*), an annual legume, for soil-building and other purposes. The crop is usually drilled in October and early November or in the late winter—February 20 to March 15—and makes its heaviest growth during late April and May. Normally, this is a season of heavy rainfall and soil conservationists have given considerable attention to cover crops such as Hubam, to afford some measure of protection from excessive run-off. Because of its luxuriant growth, usually 3 to 5 feet in height, and its very deep root system, Hubam clover doubtless has promise as an erosion-resisting and soil-building crop for use in the soil conservation program for the Blackland region of Texas.

In the fall of 1934 and the spring of 1935, the demonstration project at Temple made limited distribution of Hubam seed to a number of cooperating farmers, but unfavorable planting seasons caused poor stands. The first real test of the crop on the demonstration project came during the winter and spring of 1935–36, when the fall plantings were made with ample moisture in the soil. Much interest developed among farmers of the area because of the remarkable showing the clover made, both as a soil-building agent and as an erosion control crop. It was clearly demonstrated in this test that this legume would mature by early July, before danger of serious attack by cotton root rot.

The widest use of Hubam, in the crop disposal system, has been for green manure. Where cotton and corn followed this crop, yields invariably were increased. In 1937, yield measurements were made on several fields of cotton growing on Houston black clay which had less than 25 percent of the topsoil removed by erosion. The average yield from adjacent check plots of cotton following cotton was 257 pounds of lint per acre, while from cotton following Hubam (turned under in the summer of 1936), the yield was 293 pounds, an increase of 14 percent. Similar tests on corn showed an increased production of 16 percent on the Hubam treated fields. For the years 1937 and 1938, the average increase in cotton yield, following the clover, was 18.6 percent.

Only 1 year's results have been obtained for corn. On one farm located on the Garland project, it is reported that in 1938 wheat planted after corn produced 8.1 bushels per acre, while that planted following Hubam produced 18.1 bushels, an increase of 123 percent. Obviously the results from 1 year's observations are not sufficient for definite conclusions as to what may normally be expected.

No tests have been made to determine the residual or "carry over" effect of Hubam upon yields from the fields in the second and subsequent years. However, farmers report that cotton on treated areas has shown noticeably increased vitality the second season following the clover. An increased production for several years would be necessary to make up for the sacrifice in cotton or corn production for the year the clover was growing. However, periodic green-manure crops would reduce further depletion of organic matter and

tend to maintain crop yields at present levels. Occasionally, moisture conditions would be such that a crop of Sudan or late sorghum could be grown the same season, following Hubam. Should the recent acreage reduction of cotton and other erosion inducing crops be continued, the use of green-manure crops should prove more feasible.

While the greatest economic value of Hubam clover in the Blackland farming program probably lies in its use for green manure and as an erosion control cover, the crop affords some additional economic possibilities.

A combination use of Hubam with fall-sown oats, especially in the strip cropping of terraced farms, has been adopted by some Soil Conservation Service cooperators near Temple, Tex. The clover is seeded on top of the grain in late February, and the oats are cut for hay about May 10 to 15. With ample moisture in the soil the Hubam emerges and produces a good growth as a green-manure or seed crop. Under this practice the protection of the contour strips is afforded the soil from early winter after oats begins growth, until the Hubam is taken off in midsummer. One disadvantage is encountered with the oat hay utilization in that it is not practical to bale small amounts from the strips, and usually it is wasted badly by livestock if fed loose.

Some farmers in the project areas already mentioned have been able to market profitably the seed produced on small acreages of Hubam. In 1934 the seed was selling for about 16 to 18 cents per pound in quantities. Small amounts sold as high as 25 to 30 cents. With an average production of some 450 to 500 pounds of Hubam seed per acre, and when this yield can be marketed at 10 cents a pound, growers have found the gross return from the crop very attractive. However, in 1938, producers in the vicinity of Temple were satisfied to dispose of their surplus Hubam seed at 8 cents a pound. Probably as local supplies of the seed accumulate and as new growers learn to harvest enough for their needs, the market for Hubam seed will be very limited, except during seasons following crop failure due to drought or other causes.

Hubam may be utilized as a forage crop, although the hay produced is usually of a rather coarse stemmy quality. Livestock must learn to relish it, and some farmers have become discouraged in their attempts to get workstock or cattle to eat the hay. Some have found that their livestock readily graze the green clover when turned on it during the early spring before the pasture grasses such as Bermuda and buffalo start growth. As the plants begin to toughen, however, Hubam is not so readily grazed by stock if any other forage is available.

The Blackland Erosion Experiment Station, near Temple, Tex., is carrying out tests with Hubam to determine its place in the cropping systems for the Blackland region. The studies have not been run for a sufficient time for the officials to define definitely its possible values or its limitations.

Because of the increasing interest of farmers in this clover, it has been generally planted during 1938 and 1939 within the communities having C. C. C. camps or S. C. S. projects. Some farmers who have grown the crop are not enthusiastic about its value as a forage crop. Most growers who have been interviewed think that Hugam is much more valuable for green manure than either cowpeas or soybeans, chiefly because of the heavier growth of vegetable matter and the fact that it matures before the most active season of root-rot fungus. The protection from erosion afforded by this crop, for a relatively brief though critical period of the year, is widely recognized. As Hubam becomes better known and more generally used, it is possible that better methods will be found for handling it, and thus some of its objectionable qualities will be overcome. It is apparently the most promising legume known to be adapted, or now planted to any extent, in the Blackland area of Texas.

CUTTING AND USE OF BRUSH

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more effective and more permanent erosion-control values than if cut and placed on the ground. This consideration, which already has been discussed, should be kept in mind when planning for brush work, and might often result in a decision to leave brush uncut on a given area.

It should be pointed out to crews engaged in brush work that piñon and juniper trees require many years to grow brush in any considerable quantity. Therefore, it is best to be reasonably certain that the brush that is cut will do more good in the few years it remains in a gully than during the many years it would normally remain on the tree.

"We have numerous examples . . . of the disastrous results that have followed thoughtless destruction of certain animal populations. Animal life not only is intimately interrelated with plant life, but with the soil itself, and our knowledge of ecology is still insufficient for us to assume that we can afford to eliminate any species completely from our fauna or flora. It is only the part of common sense, therefore, to try to maintain the best biologic balance that may be attained under agricultural conditions." —Hugh H. Bennett.

MODIFIED PRACTICES FOR MICHIGAN'S FRUIT AND TRUCK COUNTRY

By F. E. CHARLES [1]

A STRAIGHT row of 10-year-old apple trees cannot be picked up and realined on the contour —and herein lies one of the erosion-control problems confronting soil conservationists in the fruit belt of southwestern Michigan.

It was at least 50 years ago that farmers along the east coast of Lake Michigan began turning to fruit and truck farming. Wheat, corn, oats, and rye—soil thieves—had used up much of the rather thin topsoil that centuries of forest cover had laid down over the sandy lower peninsula. Yields had dropped, from 50, 60, or 80 bushels to 10 or 15 bushels per acre. Such yields did not pay, and thus it was that farmers began shifting to the production of fruit and truck crops. The winds from the west were both warmed and cooled by the waters of Lake Michigan—cooled in the spring, they would hold back fruit buds until frost-free weather. The sandy soils were suitable for orchard and vineyard and garden vegetables; water was plentiful. Nearby Chicago, Detroit, Toledo, and Milwaukee and lesser cities would provide the markets.

Today, Michigan is in an excellent position to continue profitable fruit and garden crop production, provided the State's soil can be maintained. The markets still are conveniently near as they were 50 years ago, and demand has increased; Michigan is, in fact, next door to the Nation's center of population density. But the fruit and truck farmers have plowed and planted and tilled "on the square" until they have lost much of their topsoil, and now many rural residents are employed on a part-time basis in nearby cities. The three elements—wind, water, and sand—which in the beginning permitted fruit and truck crop production, have combined with the methods of farming to cause serious trouble to farmers through erosion. The winds blow the sand, often creating sand storms that rival the dust storms of the plains country in intensity if not in extent. Most of Michigan's water is in her lakes, but enough of it falls from the sky to cause extremely serious water erosion on the heavier, more fertile soils that are interspersed with the sandier types.

In the fall of 1935 technicians of Michigan's first Soil Conservation Service demonstration project began wrestling with the peculiar problems of the fruit belt to determine whether or not the soil deterioration could be halted by soil conserving practices. Two areas in Berrien County, totaling 35,500 acres, were chosen for demonstration, and the work proceeded under the interested observation of growers who never before had given serious thought to contour tillage as of special importance on their fruit farms.

Farms in the fruit and truck district of Michigan are small, averaging 39 acres in the northern part and 59 acres in the south. Of 875 farms, 273 are 20 acres or less in size. Farm planners must work out rotations and soil-saving practices for many fields—a half acre of asparagus, 2 acres of peaches, 4 acres of apples, a tenth acre of raspberries, a half acre of cantaloupes. In southwest Michigan there are 33 different soil types, 13 erosion classes, 23 important crops. Many of the crops are located on soil types not best suited to them—a patch of asparagus, perhaps, is established on a 14-percent slope when it should be on the crest of a knoll.

If diversified farming still prevailed in the area, contour farming could be more easily established. But with 55 percent of the cultivated land in orchards, vineyards, and berry patches, soil conservationists had to set their sights not 5 years but 25 years into the future. A farmer who has purchased or rented land worth $75 an acre, invested an additional $300 an acre in planting stock, fences, spraying equipment, labor, and fertilizer, and then faced the bills for taxes, interest, and maintenance until the first harvest—that farmer cannot destroy the progress of a decade by uprooting his apple trees to replace them along contour lines He cannot do this even though he knows that square farming is stealing more in fertile soil than he reaps in cash profits every year. Nor can he adopt any satisfactory scheme of diagonal cultivation that would approximate the contour, because that too would involve the uprooting of his trees. Fruit farmers do not take out their trees until those trees have passed the age of productiveness—25 to 50 years.

But, fortunately, fruit farming progresses with the seasons: Occasionally a few acres of vineyard are uprooted and new plants set out, and it is the same with apples, cherries, peaches, currants, and gooseberries. Moreover, farmers in the southern or Baroda

[1] Regional information officer, Soil Conservation Service, Dayton, Ohio.

area of the Benton Harbor project are still in the process of shifting from dairy farming to fruit growing. As such changes are made, soil conservationists make every effort to have erosion control practices adopted. In the course of 4 years, farmers have agreed to follow plans for establishment of conservation practices on about 7,000 acres.

Although Michigan State College long has advocated the correct use of soils, farmers in the fruit and truck crop area did not give serious attention to the matter as long as good yields were common, and in the meantime much of the topsoil was washed or blown away. Now, however, perhaps because it is easier to see mistakes in retrospect, correct land use is graudally revamping farm plans so that eventually crops will occupy suitable soil types. The State College is cooperating in every possible way with the demonstration project, and erosion control methods are to be widely used. In principle the methods are the same as those used in other States, but in practice they are often somewhat different under the peculiar conditions of this fruit and truck country.

This deviation in soil conservation practices, to fit them to the peculiar conditions of the area, was necessary especially in contour adaptations. Project technicians first thought that an orchard row should be on the exact contour—"Let each row hold its water," they said. But, as it turned out, percolation was sometimes slower than had been calculated, and overtopping caused trouble. Now, because there are times when surplus water must be accommodated, each row is given a "terrace grade." On light soils a grade of two-tenths foot per 100 linear feet has proved ample for rows up to 1,500 feet in length. On heavier soils the drop is four-tenths foot per 100 linear feet. Project manager Washington O'Brien sums it up thus: "Where once we used an Abney level, we now use an instrument and a rod."

Since fruit trees and bushes cannot be uprooted and replaced on the contour, in some old orchards diversion terraces are being "worked across the slope" and, although this necessitates the occasional removal of a tree, the loss is not serious in view of the fact that the practice aids in preventing soil washing.

Soil-building practices are being employed between orchard rows, and vegetation is being used as much as possible though not in the same way as in the Corn Belt and the cotton country. "We once thought a sod orchard stayed in sod," O'Brien explains. "But sod or cover crops require moisture, and competition for moisture usually is serious as summer comes on. That is why we use a modified sod; it may be anywhere from 10 to 90 percent of a good, dense sod—in any case it is the thinnest possible necessary to prevent erosion."

Modified sod is produced by chopping with a disk, usually about the time the grass begins to head out. Disks are set at just enough angle to tear the turf, check growth temporarily, and roughen the soil surface. By fall the grass begins to recover so that it will afford protection through the following winter and spring. In the old straight-row orchards the disk may be run both ways. In the new contour orchards, sod strips in the tree rows are never disturbed.

Contour strip cropping also must be modified in this fruit country, since sandy knolls dip and fold, and true contours would run almost in figure-eights and spirals. Thus, field stripping has been resorted to as a modification, but in longer rotations. This constitutes a compromise between farmer and nature, and it is decidedly preferable to breaking up all the slopes from top to bottom.

The modified strip-cropping plan used on E. W. Lindahl's field is interesting from the point of view of rotations. The plan as shown below was worked out 3 years ago by Gus Thorpe who is now area conservationist:

	1st year	2d year	3d year	4th year
Strip 1	Truck *	Truck *	Sweetclover	Sweetclover. *
Strip 2	Sweetclover	Sweetclover*	Truck *	Truck.*
Strip 3	Truck *	Truck *	Sweetclover	Sweetclover. *
Strip 4	Sweetclover	Sweetclover *	Truck*	Truck.*

* Rye used as winter cover.

Lindahl's field is sandy and much more regular as to contour than is much of the land of the area. The rotation calls for 2 years of truck and 2 years of sweetclover, with rye for winter cover in all instances when the land would otherwise lie unprotected following maturity of a summer crop.

Terraces have been tried out in considerable variation. "We believe that terracing conserves more moisture for the trees when they are set on the terrace ridge," Mr. O'Brien explains. "This moisture is a vital necessity on the more droughty soils which are rather extensive in the project area. Where orchard conditions and sites demand clean cultivation, terracing is the best method of controlling erosion and conserving moisture. The chief problem is terrace maintenance. Often, on the more sandy soils there is as much soil loss as there is run-off, pound for pound; this is especially true in southwestern Michigan where intense summer rains cause terraces to become plugged with sand fills so that frequent maintenance is required."

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Enrollees of the Soda Springs camp, building contour furrows on Darland Mountain to hold run-off water on a badly trampled sheep runway.

HUSBANDING SOIL, GRASS AND WATER ON THE AHTANUM CREEK WATERSHED

HOW TO CONTROL EROSION and conserve water under the conditions peculiar to the Ahtanum Creek watershed west of Yakima, Wash., since 1935 has been the subject of joint demonstration by the Soil Conservation Service and the Soda Springs C. C. C. Camp. The camp has recently moved to Waterville to engage in similar work there.

An inventory of the distinctive accomplishments on the drainage area of Ahtanum Creek accords first importance to the better protection of the watershed from which farmers along the creek obtain irrigation water and on which they graze their cattle during the summer. Hardly less noteworthy is the protection of creek banks where camp enrollees effectively checked the washing away of the rich soil in hopyards and orchards.

Most cooperators along the creek belong to the Ahtanum irrigation district, through which the watershed range improvement program was developed up in the Darland Mountain country 10 to 20 miles away. These farmers will continue their active efforts on behalf of better land use. The Service has established an area operations office at Yakima to direct field activities in half a dozen counties.

Back in the Soda Springs country, in the Green Lake and White's Pocket regions, 32 miles of drift fence were built to enable grazing to be managed for the permanent protection of these eastern Cascade foothill slopes. Thousands of feet of contour furrows and water spreaders to hold water on mountain meadows do their part to stabilize the summer supply of water that flows into the Ahtanum Valley ditches. In the valley additional thousands of feet of bank revetment, and rock-wire jetties, help to hold the stream to its course during high water, and keep the soil from washing down the creek.

More than 26,000 acres are involved in the conservation development, some 23,000 acres comprising the upper watershed work.

At one time, thousands of cattle, sheep, and horses were run on the Ahtanum watershed. Finally, both Soil Conservation Service and local ranchers agree, overuse took off the protective natural vegetation to such a point that quick run-off in the spring was followed by earlier irrigation-water shortage in the summer. In the early 1920's, a consistent reduction of stocking was begun under direction of the State land commissioner, but further refinement of the managed grazing program remained to be done when the C. C. C. camp was located there.

Service technicians found the range had suffered from premature grazing in high elevations and from

heavy overgrazing near salt ground and areas of choice feed. Wallace Wiley, member of the irrigation district and of the local Cattlemen's Association, is authority for the statement that at one time "there were more sheep on the upper end of Ahtanum than are in the whole county now." Fires added to the damage from overgrazing.

The C. C. C. program was developed under agreement with the State of Washington, which owns alternate sections, a railway company which holds odd-numbered section grants, and the Ahtanum irrigation district, which purchased some 8,000 acres in the watershed. The range area was divided into a dozen or more pastures, so that the cattle—only 625 head now—can be split into small bunches and grazed progressively over different sets of pastures through the summer season starting June 15. The drift fences were built of poles from nonmerchantable timber, connecting with natural barriers wherever possible.

The subdivision of the range, with carefully figured carrying capacities, permits proper use of the lower pasturage without grazing higher areas until the grass is far enough along to be pastured without damage. Provided in each pasture are new salting grounds removed from points of overgrazing or congregation. Although springs supply adequate water over most of the upper area, several small stock water dams were built to store snow water for summer use. Beaver dams also aid in holding water upon the watershed. The animals were trapped lower down the streams where they were damaging trees in farming sections and placed upstream where dams were needed. This program was in cooperation with the State game commission.

No logging operations are carried on now in this part of the Ahtanum watershed. Nearly 400 acres of trees were planted by camp workers. The enrollees also completed the Soda Springs-Darland Mountain Road, so that it now is more useful for fire protection and other purposes.

As stated by Judge John H. Lynch, secretary of the Ahtanum irrigation district: "We had better water in the valley last year than at any other time since 1916."

MODIFIED PRACTICES FOR MICHIGAN'S FRUIT AND TRUCK COUNTRY

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In an area so intensely cultivated, attention given to farm wood products naturally is at a minimum. Because of their large investments in the land the people of Berrien County feel that they cannot wait for forest trees to grow. On the other hand, there are two very good reasons why trees should have a place in the erosion control program of the area. First, these farms have constant need for wood products; fences must be built, trellis posts must be available for the vineyards, lumber and fuel always are needed. In the second place, Berrien County is spotted liberally with "blow-outs," and a soil blow-out is as serious in Michigan's fruit section as it is anywhere else. When sand begins to blow it is difficult to bring it under control. Farm woods have proved that they can do the job better than anything else.

What do cooperating farmers think of this program—farmers who have $10,000 to $15,000 investments in 40-acre farms?

Two years ago, Ben L. Sill set 5 acres of peaches on the contour and with proper cover crops between the rows he has stopped erosion, even on slopes up to 14 percent. "I am going to plant more peaches next spring, and they will be on the contour," he declared, and, later, working in his berry patch, Mr. Sill pointed out damage to the soil between straight rows from a heavy rain: "These plants will come out next year, and the peaches will bend around the hill to connect with other contour rows. Raspberries, too, will be on the contour." In an adjoining orchard, Mr. Sill's son was planting a cover crop and complaining that "it should have been done earlier." The date was July 19.

Not far down the road, Emerson Cryan pointed to strip cropping on the far side of his "eighty." He was emphatic when he declared "I have no objections to it. It is just as easy as the old way, and I think the horses know every curve. They could follow the rows with their eyes shut. Besides, there is an advantage in carrying out the tomatoes: We merely drive the truck into the meadow strip and carry out the tomatoes, both ways from the middle. We used to have to move the truck in the patch."

Cryan's farm is an excellent example of correct land use. A flat, high hill is in orchard; the sharp slopes and knobs, where the land breaks away, are in permanent pasture; and the gentler lower slopes are in a 6-year rotation of tomatoes, corn, and 4 years of alfalfa. Flat bottomland is utilized in a 3-year rotation of corn, small grain, and clover. Mr. Cryan himself relocated his fences to run on the contour.

The cases of Mr. Sill and Mr. Cryan are average for the area; there is, in fact, a high degree of satisfaction

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FOREWORD

Mr. McAtee needs little introduction to a Soil Conservation Service audience. From the inception of field operations on the old Coon Creek project in Wisconsin down to the issuance of this number of our magazine, he has manifested the liveliest interest in our activities and has contributed in every way possible to the solution of our problems. He has inspected soil conservation work on the Coon Creek project, on the Navajo Reservation, and on several projects in the Southeastern region. He is personally known to many of our staff members in the field as well as to those of the Washington office.

Nevertheless, even at the risk of repeating what already is well known, we should like to point out that aside from the reputation Mr. McAtee has won during his 30 years' study of the economic relations of birds, he also is widely known through his philosophic writings in the field of evolution. It would be difficult to find in America one who can speak with more authority on the subject of biologic balance.

Therefore, with keen satisfaction we announce that we have been successful in persuading Mr. McAtee to amplify for our readers the principles which we sought to present in the recent wildlife issue of Soil Conservation.

Ernest G. Holt,
Chief, Biology Division.

BIOLOGIC BALANCE ON THE FARM

By W. L. McATEE [1]

BIOLOGIC BALANCE is the term heard today for what yesterday was called the balance of nature. Some would assume that the primitive balance of nature such as obtained in America in precolonial times has been destroyed by civilized man and under his domination cannot return, and they would therefore deny the present existence of any kind of balance. It may well be that in their assumption they would be correct, for in all probability man's abrupt and wholesale remodeling of the landscape and his ruthless interference with its plant and animal inhabitants never can be assimilated into nature's more deliberately adjusted system of checks and balances. In their denial they would be wrong; they would have overlooked entirely *nature's power of recovery*—and it is here that the biologic balance enters the stage.

No sooner does man's disturbing influence anywhere cease than recovery begins. Unless all fertility has been swept away, bare ground soon is occupied by weeds. Grasses come in next, and if there is enough moisture they are followed in time by shrubs and trees. Cut-over woodland, if not too much damaged by fire, will produce a new crop of trees in a human generation. Practically all the deciduous forest in the eastern United States is this so-called second growth—a vast tribute to nature's power of recovery.

Where a little herbage is established, insects are attracted, and soon birds drop in to snap up a few of them. When the grasses and weeds produce a fair crop of seeds, mice come to take toll of them, and when there are enough mice the weasels do something about that. Juicy greens and the tender shoots and bark of shrubs draw cottontails, and enough of the bunnies attract the foxes.

None of these things happen suddenly, nor until the way has been prepared for them. They come about in a gradual and orderly manner—*naturally* in the truest sense of the word. As a philosopher once put it, "Nature abhors a vacuum," but these are hard words, meaning in the present connection only that life pushes in anywhere it has a chance. All life provides food for other life, and it is evidently a natural law that no food supply is left untouched. Further, the natural law seems to decree that while all food supplies may be utilized, none may be utterly consumed.

It is a general habit of animals to sample foods here and there; rarely do they make a clean sweep of anything. This habit contributes to biologic balance, as the toll taken is not so great but that the remainder is sufficient to maintain the food species in about their average abundance. Thus the greenery about us looks much the same from year to year; the insects dependent on that foliage neither increase nor decrease except sporadically; and birds that prey upon the insects retain their average numbers through the years.

These things speak eloquently of biologic balance, and there is a reason. Nature, while tolerant and slow, is inexorable. If a species too largely consumes its food supply, its own numbers will decrease. It may live comfortably on "interest" for years, but let it eat

[1] Technical adviser to the Chief, Bureau of Biological Survey, U. S. Department of the Interior, Washington, D. C.

into the "principal" and its own account in the bank of life soon is overdrawn.

The workings of nature's balance are evident not merely in a broad sense but also locally. In fact, natural law is the summation of local happenings. Not only is this true in logic but also in reality, for the reason that living things, as a rule, are very localized. As to plants, the condition is obvious and it is likewise true that individual animals do not range widely. Migrants are the apparent rather than the real exception, as individuals and groups keep to certain areas in both their summer and winter homes. Even their migration routes are relatively fixed. In general, territorialism rules, and it contributes a great deal toward balance.

Territorialism is the name we have for nature's system of parceling out places to live. An individual plant occupies a comparatively small territory—that traversed by its roots and branches. Usually conditions are not so uniform but that some other plant is a little better fitted to occupy an adjacent nook, whether made by vertical or horizontal variations in soil or moisture. Mixtures are the rule, pure stands the exception. Each plant draws certain substances from the soil and adds others to it, thus maintaining average fertility. To resume the banking simile, demands and repayments by each living thing are different, but in the long run a fair balance is struck.

In contrast to plants, animals seem very free moving; but even their movements are limited. The territory of a pair of small birds in the breeding season may be less than an acre in extent, and a family of bobwhites may never range more than a quarter of a mile. Mice may be restricted to a fraction of an acre, squirrels to a radius of a few hundred yards, and cottontails to from one to several acres. In general the larger the animal the more extensive the territory, but in any event it is not indefinite.

Territories seem to depend upon the degree of intolerance animals have for their own kind. When the bounds are overstepped, conflict soon results and the trespasser, as a rule, is glad to retire to its own domain. The result is that creatures are confined almost as by a fence, inside of which they must comport themselves so as not to spoil their own living. If they materially damage the range, it will then be lost to their species for a time. With such a system in operation, almost everywhere, it is apparent why natural balance usually prevails and why if disturbed it tends to return to equilibrium. Unbalance automatically brings correction.

Balance results from equalization of opposed forces, and in nature these may be conceived of as a tendency for life to remain localized and hold its place, offset by another tendency under which it spreads and fills any unoccupied habitat. The former leads to the holding of territory, the latter to pioneering, and as a result of their interweaving, the woof of life always pretty well fits the warp of environment. This is certainly balance.

The web is woven only as life is sustained by air, soil, water, and other life. In the realm of sustenance, also, balancing factors prevail. Where there is food, something will come to feed on it. If feeding goes too far, the feeders must retreat. Under natural conditions consumption is more or less in proportion to the supply and does not materially encroach upon it. That is balance.

Where encroachment is noticed, it may usually be traced to some unnatural condition produced by man. That is unbalance. Wherever there is unbalance, nature seeks to correct it. Balance, if not always evident, may be said to be ever imminent.

When a working balance becomes established, regardless of the changes, it may be at a new level, and whether or not on that level it is advantageous to man depends greatly on what he has done. If, for instance, he has practiced clean farming to the extent that there is little nesting cover for birds, sufficient cover will nevertheless remain for insects, and they will increase. Their own internal wars will produce some sort of balance, but it will be at a higher level and there will be more insect mouths to feed. The farmer will have given aid and comfort to the enemy. If he allows the fertility of the soil to fall, as by uncontrolled erosion washing away the loam, the inhospitable subsoil will support fewer and less desirable plants. Vegetation will do its best to reoccupy the land, but for a period it will be sparse and weedy and will support little animal life of value to the farm. The web of life is stretched thin to cover a barren place. There may be balance but it will be at a lower level than before. If destructive influences cease, conditions will improve slowly under nature's management, though more rapidly under man's if he will but make the effort. Enrichment instead of depletion of environment should be his conscious goal; and when that ideal steadily prevails, there will be a different, a far more satisfactory tale to tell of man's progress in getting along with nature.

The phrase "balance of nature" admittedly is a figure of speech, but it is a justifiable one. Balances always tip up and down before they equalize. The balance of nature is such a tipping balance because all animal and

plant populations are ever fluctuating. But just as truly as a weighing balance seeks equilibrium so does that of nature.

This is no more difficult to understand than is the fact that if the grass is scanty here and lush yonder, grazing animals will feed "yonder"; automatic equalization takes place at once. If sumac bushes along the edge of the woodlot are shaded out, cottontails which feed so much on sumac bark may have to leave the dying thickets and come perchance to a hedge near the garden where they may do damage. If mice in grassland are killed by burning, weasels that would prefer to feed upon mice may be forced to look elsewhere for food, possibly in the chickenyard. If some isolated, densely branched and prickly trees, as thorn apples or red haws, are preserved or grown, kingbirds will build their nests in them and from these airy castles harass crows, hawks, and buzzards, so that they no longer can do as they please. The kingbirds will also consume thousands of insects during the summer.

The operations of nature's balance are going on before our eyes at all times and to realize it we need only take a little thought as to causes and effects. Everything that happens has a cause and produces an effect, and these effects in turn become causes. The far reaching effects of a hard winter or of a drought are familiar examples. As a result of such climatic severities, trees may die at once or be so injured that they succumb later. Every tree that perishes has been host to many kinds of insects who must find another home or die. The insects have regularly paid an endurable toll to various predators and parasites which must now levy their tax elsewhere or cease to exist. The trees that die have shaded the ground but now the sun strikes through their leafless branches, stimulating to rapid growth plants previously suppressed and seeds that have been waiting, possibly years, for this opportunity to sprout, grow, and reproduce their kind.

Each new thing attracts a company of dependents, so that under the dead tree a plant and animal society very different from that previously dominant may come to rule. The lifeless bole and branches themselves provide homes and food for fungi, insects, and other organisms that could not successfully attack the tree in life. Each being in the association depends upon and prepares the way for others. This is just as true of the farm as of the woodland; a source, perhaps difficult to trace, may have a great result, though acting through a number of links in the chain of cause and effect. Such a series is like the file of wooden soldiers familiar in childhood; let one topple and down go the rest. To return to the warp and woof simile, the web of life is so involved that no thread may be added, none withdrawn, without in some degree affecting the whole pattern. No wonder then that man's usually unconsidered and ruthless alterations have unexpected and regrettable effects. Barren wastes where prosperous civilizations once reigned clearly show him that if he desires to occupy the earth in anything like present numbers, he must pay more attention to balancing factors and work with, rather than against, nature.

Observation teaches that natural balance, like good housekeeping and good husbandry, is guided by the rule "A place for everything and everything in its place." It takes every kind of place or "habitat" natural to an area to ensure the presence of all factors necessary to working of the biologic balance. The farm that keeps intact all natural nooks, and produces wildlife food and cover that is as widely distributed and abundant as is compatible with successful farming, will come nearest to attaining that biologic balance so necessary to wild creatures and so beneficial in enlisting all the aid that nature can give in maintaining the farm. In the light of the balancing principles of holding territory and pioneering, it is encouraging to the individual landholder to realize that attractive territories for numerous kinds of wildlife can be established entirely within the boundaries of his own place, that he can successfully practice wildlife management whether his neighbors do or not, and that the zeal of wildlife in finding all favorable places ensures that the territories he preserves or creates will be found and occupied.

The farmer who insofar as possible preserves natural conditions and encourages biologic balance, contributes not only to his own welfare but also to that of the Nation.

MODIFIED PRACTICES

(Continued from p. 96)

with the soil conservation program among cooperators. Of 131 agreements, not one has been canceled through disagreement or disappointment with the farm plan. Only 6 agreements have been canceled, and these by deaths or sales.

So much for cooperators. As for noncooperators, Mr. O'Brien gives us an intimation of the future of soil conservation in the Michigan fruit and garden crop area in the following brief statement:

"In the last 6 months I have noticed that a lot more farmers are asking questions about erosion control."

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

VANISHING LANDS. By R. O. Whyte and G. V. Jacks. New York, 1939.

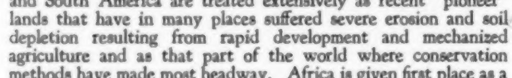
This is the most complete treatment, in a single volume, of world-wide erosion problems yet to appear. It is especially valuable to us in that it is produced by two distinguished British scientists who know intimately erosion conditions in not one country but many, and who have followed with intense interest the details of the soil and moisture conservation work in the United States. Dr. Whyte is Deputy Director of the Imperial Bureau of Pastures and Forage Crops; he is also, as we all know, the editor of *Herbage Reviews* and it is not necessary to point out here how valuable that publication is and will continue to be to soil conservationists in this country. The second author, G. V. Jacks, is Deputy Director of the Imperial Bureau of Soil Science and, judging from his works in this volume, he is also something of a social scientist and an economist as well as a soil scientist.

The British edition of the book is called "Rape of the Earth," and was especially designed for use in disseminating erosion information and coordinating conservation work throughout the countries of the British Empire and the United States. The two authors do not collaborate on the book as a whole; 12 of the chapters are by Dr. Whyte and the remaining 10 are signed by Mr. Jacks, although it is apparent that both scientists have a thorough understanding of all phases of their broad subject.

The book treats erosion history and erosion consequences of practically all the lands of the world as a whole. European and Asian lands touching on the Mediterranean are discussed under one heading as to old and new erosion problems, and North America and South America are treated extensively as recent "pioneer" lands that have in many places suffered severe erosion and soil depletion resulting from rapid development and mechanized agriculture and as that part of the world where conservation methods have made most headway. Africa is given first place as a desiccated continent where erosion is still gaining momentum. Australia and the United States are compared in various ways and land types, and the decision of Dr. Whyte is that the rate of erosion in the former is greater than in the latter country. The Orient is treated in an interesting and unique fashion—as the place of "old age" erosion where soil misuse has had tremendous economic, political and social consequences. Japan is spoken of as the country where "erosion control has passed from an experimental science into a firmly established art" for the reason that Japan must protect her soil or end as a Nation.

Two chapters by Mr. Jacks on soil erodibility and the principles of soil conservation lead to Dr. Whyte's discussion of the agronomical practices of the Soil Conservation Service of the United States, and seven chapters deal with these special conservation problems: Reclamation of gullies; pastures, ranges, and veld; trees and agricultural conservation; dust, dunes, and deserts; water conservation and flood control; road construction and soil conservation; wildlife resources in relation to the soil and to human beings.

Mr. Jacks writes the last six chapters of the book, giving a dignified, clear, and very readable presentation of the economic causes and consequences of erosion and the political and social consequences in grassland environment, in tropical Africa, and South Africa. Some rather profound ideas are introduced in the final chapter, particularly those regarding settlement of semiarid lands and population density on any land. This chapter constitutes an excellent thought provoker for those who realize the relationships between population and the balance of soil fertility.



The fact that "Vanishing Lands" was chosen by the Book-of-the-Month Club as the outstanding book of the September lists is most gratifying to American conservationists as well as to the distinguished British authors.

WATER—WEALTH OR WASTE. By William Clayton Pryor and Helen Sloman Pryor. New York, 1939.

This might be called a "water panorama" and certainly would prove useful in the educational program of the Service. It is excellent reading not only from the standoint of the conservationist but from that of the general reader with lively interest in historical facts as related to natural resources of the planet on which we live. The theme is wise use of water; by tracing the pattern of human migration and achievement, by way of rivers, oceans, aqueducts, and plowed furrows, the authors have drawn a vivid picture of the vast subject of the great "ally or enemy," water, and its importance to individuals and nations. Chapters treat single phases of the great subject in relation to its effect on human destiny—history's highways, the rivers and the seas; water supplies for cities and why men toil and millions are spent to lay great aqueducts; water for recreation and for beauty; man's short cuts to places near and far by way of canals; water for power; the denizens of waters from the food fish to the versatile coral who can build a necklace or an island; water in mining, the ally, or water in mines, the dreaded enemy; water in the factory, the laboratory, the home.

The Pryors tell a vivid story of contaminated water, by way of India and 16,500 dead while an old Hindu custom spreads cholera, and by way of a little "inn of death" and typhoid in the United States. They point a sharp lesson when they write down for all to read the incident of the "upper middle class" people who, rather than pay small charges for the use of a town-sewage system, preferred to dump refuse into a stream that provided a water supply for a city of 25,000 other people 9 miles away. Still in story form, the authors then give us two excellent chapters on floods and flood control. The flood left a "high-water mark," on the house and in the mind of the child who "had no idea what had caused the flood." This book if placed in the hands of an eighth-grade child would be read with eagerness, and that child would learn what causes devastating floods, and that to cure the Nation of floods "a combination of remedies must be applied." Woods and forests, better designing of fields and cropping on farms, flood basin development, careful planning for future cities and towns—these flood-control methods are discussed and defined as to relative importance in curing the Nation of floods.

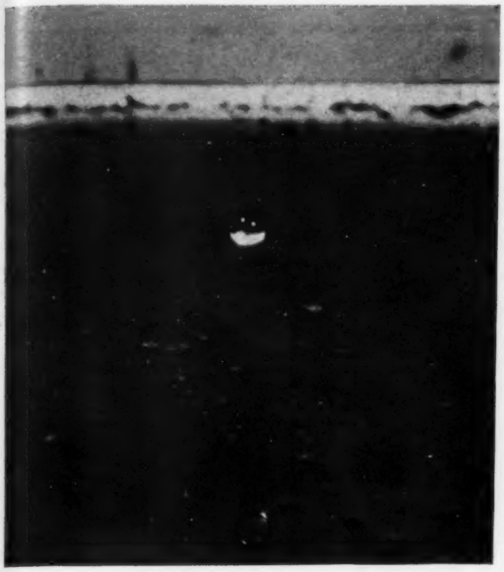
"So trees do us two favors: they consume water and they put brakes on the slide of water and of soil down to the sea." . . . "Levee building has been a brave effort, but it does not work for our wild Mississippi." . . . "Farms must be planted *differently*"—these are sentences taken at random. And then come two chapters on water and the land, the farm. The story of farmer William Shepherd which begins in a "little frame farmhouse in the Dust Bowl" is an inspiring story in spite of its pathos. For this farmer bade goodbye to his neighbors as they left their farm to the dust and sought the long road; he attended a meeting in the town and invited a "soil expert" to his farm. He terraced his land, he plowed according to the slope of his land, he left the roots and stalks in his fields after harvest, he adjusted his crops to his fields—he conserved the moisture and saved the soil. He and his family were happy again, within 1 brief year, because they had stayed at home and saved their land.

The authors of this book are expert photographers, and the publisher appreciates the value of fine pictures in illustrating a story about water in relation to the people. Fifty-six exceptionally fine rotogravure reproductions have a great deal to do with its being recommended here for upper-grade schools.

U. S. GOVERNMENT PRINTING OFFICE: 1939

THE CAMERA "STOPS" A MOVING OBJECT

by J. Otis Laws



The action of a drop of rain upon striking the soil has been made the subject of a photographic study in which the high-speed apparatus of Edgerton, Germeshausen, and Grier of the Massachusetts Institute of Technology was used.

Two different techniques were employed in the study. With the Edgerton stroboscopic camera, photographs were made at the rate of 1,100 and 660 per second on a 35-mm. film. The pictures showed the whole process in minute stages and thus are valuable in observations of raindrop action. The second technique employed a 9 by 12 still camera and the Edgerton "single flash" lamp, and because of the greater amount of light and the larger film, photographs of superior pictorial qualities were obtained.

Nine series of pictures were taken with a stroboscopic camera, representing drops striking three soils and three moisture conditions. The soils were Georgia Kaolin, Vernon very fine sandy loam, and Cecil clay loam. The three conditions were air-dry, wet, and flooded.

The photographs taken on the 35-mm. film with the stroboscopic camera made possible a detailed study of a phenomenon, the results of which have recently been observed experimentally. It has been determined that the disturbance of the soil surface by the beating of large raindrops is accountable for a significant portion of the soil eroded from bare surfaces.

The techniques used in this study are applicable wherever rapid motion obscures the details of the phenomenon being examined. The exposures possible with this apparatus are sufficiently brief to "stop" even rapidly moving objects. The duration of the exposures used in making these photographs was about 1/200000 second.

A 45- to 50-year stand of Virginia pine, showing understory of hardwoods (dogwood, sweet gum, black oak) about 17 years old. Lehigh soil.

(See article beginning on opposite page.)